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GULF BIOLOGIC STATION

CAMERON, LA.

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WM. H. GATES

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OYSTER CULTURE IN LOUISIANA

The following bulletin is issued with the intention of placing a few facts as to oyster culture plainly before the average oysterman of Louisiana. Many persons undertake the cultivation of oysters without the slightest knowledge of the fundamental principles that govern the setting of spat, the growth of the young oyster, or the methods of marketing. Some oystermen are highly successful at cultivating oysters and their neighbors, only a few hundred yards distant, obtain but poor results from their labors.

The writing of a short comprehensible bulletin was suggested to the author after having spent nearly two years in the oyster fields of Louisiana and trying to show many of the men the whys and wherefores of their success and failures. The idea of the bulletin being to give suggestions which the average oysterman can turn to practical advantage. A slight knowledge of the life of the oyster ought to help materially in understanding the conditions under which it will develop to the best advantage. For that reason a brief outline of the life of the young oyster from the egg to the adult is here given.

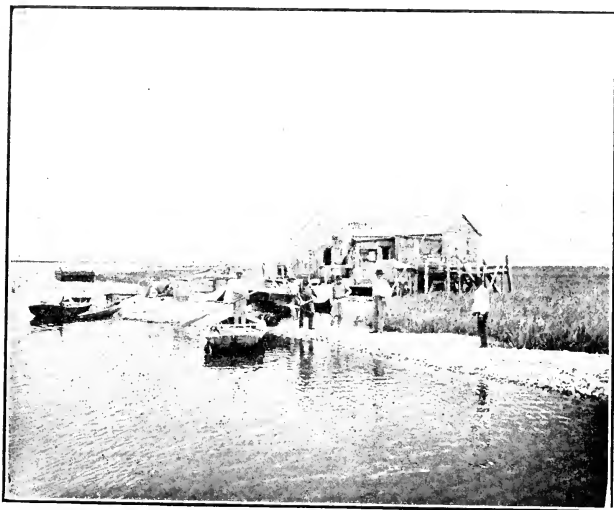
LIFE HISTORY.

The American oyster is unisexual, that is, each animal is either male or female, but not both as is the case with the European oyster. When the sexual products are mature, they are cast out into the water; and the eggs are left to chance to become fertilized and to develop. On account of this element of chance, and the fact that the young oyster serves as food for many other animals, the number of eggs produced by each female is enormous, varying according to several estimates from 15,000,000 to 90,000,000. The egg must be fertilized before it can develop, and this is accomplished by the union of a sperm cell with an egg. This takes place after the egg from the female and the sperm from the male are cast out into the water. After

fertilization, the egg develops rapidly until it has reached the stage where it has acquired a tuft of hairs at one end of the minute body mass for as yet it has no definite structure and becomes a free swimming animal. In this condition it swims actively through the water and grows. Development may be fast or slow according to the condition, its growth depending upon the temperature and the food supply. Without food, or at low temperature the young oyster may be kept two weeks or more with but little development. Under normal conditions, however, after swimming freely in the water about two weeks it attaches itself to some object and begins its sedentary growth.

It is during the free-swimming stage that the spawn is distributed throughout the waters. The swimming movements of the young oyster are directed mainly to keep the animal at the surface of the water, and not for progression in any desired direction, as with or against the current. The young oyster known at this stage as the larva, is not a strong swimmer and consequently is entirely at the mercy of the currents, winds and tides. In this way the larva floats, now in this direction, now in that; some are carried far out to sea, others are drifted into fresh water, and still others are washed ashore. Thus it is, that during the height of the spawning season one can hardly dish up a bucket of water anywhere in salt or brackish water without finding several oyster larvae in it. The larvae at this stage are just barely visible to the unaided eye and look like a tiny bit of chalk. The shell has already started to form, but the two valves are more nearly symmetrical, and it looks more like what one might imagine to be the young of the quahog clam than an oyster.

The free-swimming stage in the life of the oyster is a wise provision made by nature for its distribution. Where the spawn is drifted into one of the ocean currents, it may be floated hundreds of miles out to sea. Even under natural condition of our tides west of the Mississippi River, and away from the influences of any river, young larvae have been found in the gulf, in searce numbers, at least ten miles from the shore, and probably more than that from any oyster beds. Likewise it has been caught in inland lakes where waters are absolutely fresh.



I.—AN OYSTERMAN'S CAMP.

This is a type of the more substantial oyster camps found on the coast. The leased land belonging to this party lies directly in front of the house. The man and his two sons live here the year round, and thus are able to work the grounds constantly; but better yet are able to fully protect their property. These men are hand tongers, yet they have made oystering a profitable business.

excepting, near the outlet which becomes brackish at times, due to "backing up" of salt water.

TOWINGS.—As stated above, the swimming movements of the oyster larvae are directed chiefly towards keeping it at the surface of the water. At a depth of sixteen feet comparatively few larvae are found, somewhat more during mid-day and after a heavy rain, when the water density is several points less at the surface than at a depth. But the difference is not so much as might be expected. An average of fifty tows made under like conditions in approximately the same locality and at the same speed and extending over a period of just thirty minutes, showed approximately ninety-two thousand larvae caught in a tow net seven inches in diameter. An average of forty tows, sixteen of which were made simultaneously with the above, only at a depth of 15 feet showed approximately 500 larvae at each towing. While at a depth of 20 feet, 96 was the most counted at any one time. The summary of the following tows taken at about the same season, but in a different locality, showed these results: the average of 54 tows at the surface about 108,000; 38 tows at depth of 10 feet about 5,000; 38 tows at a depth of 15 feet about 800. The above is the record of tows made at all hours varying from 4.00 a. m. to 11:00 p. m., under all conditions of weather, cloudy and clear, and in temperatures of water varying from 18 degrees to 31 degrees Centegrade, 64° to 88° Fahrenheit, and water density varying from 1.0150 to 1.0280 (corrected for temperature), there was a slight decrease in numbers of larvae at a depth when tows were made from 10 a. m. to 3 p. m. An average of 8 tows made after heavy rains showed the following: At surface, 60,000, at ten feet, 9,000; at fifteen feet, 2,000.

At the end of two weeks, normally, the time varying according to conditions of food and temperature, the oyster larvae either attaches itself to some solid object or settles to the bottom. This is a critical time in the life of the oyster, and it is at this age probably that more oysters perish than at any other time. The free swimming larvae are the prey of, and go to make up the food of millions of other animals. Such fishes as the Menhaden, Mullet and others that get their food by

straining out the minute particles from the water. Molluses, shrimp, worms, hydroids ("frog's hair" and small jelly fish), sponges and even the adult oyster itself which may destroy many thousands of its own spawn, all help to diminish the number of larvae by using them as food. But in spite of all these natural enemies, the actual number destroyed by them probably amounts to a far less percentage than what die from lack of suitable conditions to continue growth after reaching the stage where they must attach themselves for further growth. Of the millions that are carried out to sea, or drifted into fresh water, or fall on a soft muddy bottom, not one is destined to survive. At this stage, the larvae need some clean surface to attach themselves to. If they do not find it, they fall to the bottom and soon perish. The surface on which they are destined to become attached, must be free from slime and other animal or vegetable growth. If favorable conditions present themselves, the young oyster attaches itself by one valve to some solid support, and remains there for the rest of its days.

THE FEEDING OF THE OYSTER.—From now on, the oyster is permanently fixed, and both food and oxygen have to be gotten from the water immediately surrounding it. The food of the oyster consists mainly of microscopic plants, such as diatoms, and floating bits of sea algae. But the oyster cannot discriminate and may take in or reject everything that is caught by the gills.

Prof. James L. Kellogg, of Williams College, who has made a specialty of the study of the ciliary mechanisms by which minute organisms, floating in the water, are collected by the gills and either passed on to the mouth or thrown out, states:

"It appears that the animal (oyster) is not able to distinguish food from mud particles, either by the gills or by the palps (lip-like process around the mouth) but the selection of food results directly from the differences in the response of the palps to varying *quantities* of matter transported to them by the gills. Under favorable conditions, diatoms are collected a few at a time, and are sent across the palp ridges to the mouth. In muddy water, the particles increase in number until the



II.—AN OYSTER CAMP.

In several parts of the state the oystermen live in just such camps as this. The only furniture is two or three home-made chairs and an elevated bunk, which extends the length of the hut, and on which eight men sleep. In case more room is needed, the men sleep in rows under the bunk on the floor. This particular camp is one of a group situated on Bayou Brouleau.

palps respond by diverting *everything* received, to the *out-going* tracts."

We thus see that everything fine that is floating in the water is liable to be taken up and utilized as food by the oyster. But it must not be supposed that the oyster is obliged to swallow everything that is brought to the mouth by the ciliary currents. If the water is unusually muddy, a large amount of sediment is necessarily strained out by the gills, and whenever the accumulation made by the gills is accessive the whole mass is thrown out at one definite region. Unless there is a strong current of water, this mass is not always cleared away, and, since the oyster has no way of getting rid of this waste, aside from discarding it from the edge of the mantle, it remains in the inside of the shell in the form of a dark streak. This is more or less irritating to the soft body of the oyster and so it soon secretes over it a thin layer of lime or shell matter. This layer is added to constantly, and eventually the streak of mud may be so covered up as to be no longer visible. The photograph in plate XI shows shells picked up at random from oysters growing on a muddy bottom. Some of the streaks are fresh and are covered by only one or two extremely thin shell layers; others have lain in the shell so long, that by successive layers they have become hardly noticeable.

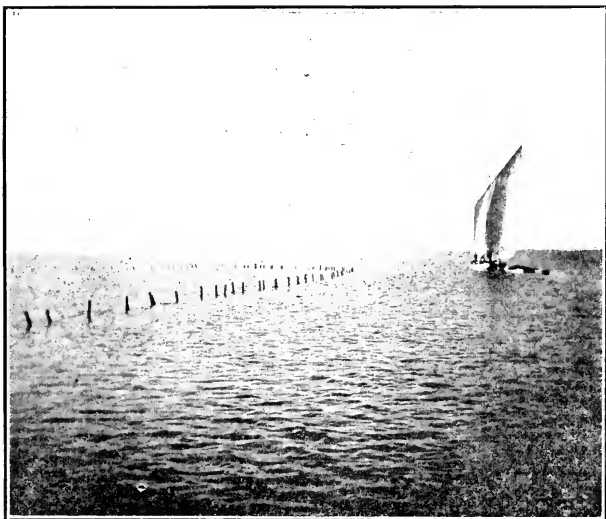
Generally the presence of these streaks indicates that the oyster has been growing on muddy bottom, or that the water contains a large amount of sediment. If the amount of mud collected by the gills is so large that the oyster is continually having to throw out the waste, it will partially starve itself, owing to the fact that both sediment and food are collected at the same time, and if the former is in excess, the latter passes out with it. As stated above, the oyster cannot discriminate between food and that which is not, it swallowing everything that is brought to the mouth by the ciliary currents of the gills or so-called palps or lips. At times, and this is not infrequent on our coast, there is such an over abundance of food (diatoms) in the water that *this* has the same effect on the oyster as if it were sediment. Thus it is, that food, if collected in excessive quantities, is cast aside, and the oyster may actu-

ally starve while surrounded by an overabundance of food. Oysters taken from hard bottom in a shallow bay containing clear water, in midsummer, have been found to contain lines of waste-extrusion, which upon close examination, were found to contain practically nothing but diatoms, which are unadulterated food for the oyster; yet due to its excess, it was not utilized.

PRACTICAL PROBLEMS INVOLVED IN OYSTER CULTURE.

Let us now consider some of the practical problems that confront the average oysterman in regard to cultivating oysters for the market. As has been stated before, the young oyster larvae are found everywhere in the waters during the spawning season, being drifted here and there by the current, so that as far as collecting spat is concerned, it matters not what bottoms are selected for oyster beds. The spat is everywhere, and any place of attachment may become the abode of the young. There are enough larvae floating around in the water, even out in the Gulf many miles from shore, to form a bed of any size, anywhere in our salt or brackish waters. This was instanced at one time by an enthusiastic oysterman who brought to me a twig of a tree, which had been lying in the water in a bay that was all but inclosed, and in which was soft mud to a considerable depth. This twig was thickly covered with oyster spat, from one to three weeks old. It evidently had been in the water about three weeks and being clean, soon became covered with young oysters. The man remarked to me as he showed me the twig: "What an excellent place to start an oyster bed! Just see how the oysters settle."

SPAT COLLECTING.—The mere fact that market oysters are not found everywhere would not indicate that all such places are not favorable for their growth; since it may only be that suitable place of attachment is lacking which keeps certain localities bare. There is then but one condition which one must consider in the mere collection of spat and that is a suitable place of attachment. Spat will settle and start to grow even in the most unfavorable localities, but if conditions are too adverse, it may not even grow to where it is plainly visible to the unaided eye. Our first consideration, then, is, what material can be



III.—AN OYSTER BEDDING GROUND AND LUGGER.

This bedding ground is located near the mouth of the Mississippi river to the westward. Note the type of lugger (so called from the lug-sail) that is used for oystering. The lug-sail is especially adapted to catch the wind in sailing along the bayous bordered with trees, and to hold the light breezes of midsummer. This type of sail will "hold up" better to the wind than the cat-rigged sail, and consequently will sail better along the narrow, winding bayous of the state.

utilized as spat collectors. Such material as gravel and shrubbery which are used in some places, need not concern us, since they are all together impracticable on our coast, especially in the best oyster regions. There are, however, two sets of materials which are very satisfactory and which are easily obtainable. These are oyster shells, and so-called clam shells, the latter are found, forming banks on the shores of many of the inland bays and lakes, and consists of shells of the *Gnathodon* and *Area*. These "shell banks" contain immense quantities of whole and broken shells. These shells, after they have been washed up into banks by the waves, and thoroughly dried in the sun, make the finest sort of spat collectors. In this condition they are clean and free from all foreign growth; a condition which is very essential to spat collection. Their size also commends them, since it is impossible for more than one or two oysters to mature on each shell.

Spat always settles in far greater numbers on any clean surface than can possibly mature. For instance, Dr. Kellogg cites a case in Calcasieu Parish, where 350 young oysters were counted on the inner surface of a shell approximately 2 by 1½ inches. Dr. Glasser records a case of 478 spat on a single oyster shell, and also gives the average of young oysters on 100 shells as 87 each.

To quote from Dr. Kellogg's report: "Once fixed, the oyster must remain. But, starting with an even chance of obtaining food, each makes a desperate struggle against all the others for existence. They soon begin to crowd. Those that happen to be attached nearest the mud are sometimes covered by the settling deposit until they are forced to close the valves of their shell and cease feeding till the tide-current is sufficient to re-open it. In the meantime their fortunate companions above the mud have been taking food and growing. This is repeated day after day. Often the food obtained is not sufficient for existence and some perish.

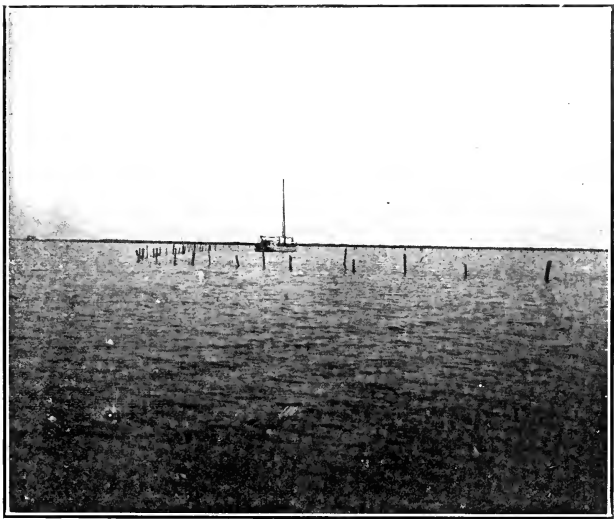
"Then those attached above the mud struggle for space. They touch and crowd and can only increase in size by elongating, and as the individuals are so tenacious of life, we soon have clusters of long, narrow, stunted, 'raccoon' oysters."



With the small shell the crowding begins early, and soon all but one or two have perished, leaving good opportunity for those that survive to grow. Yet granting that better results may be gotten by the use of small shells for spat collecting, it must be understood that just as good results can be gotten by using dried oyster shells and "working" the beds, that is, breaking up the clusters in one way or another.

It has been previously stated, that shells cleaned and dried by the action of the waves and sun, make ideal spat collectors. There is a reason for this. There are many places along the Gulf where, at one time, there have been large oyster beds. But due to the excessive tonging these have become extinct, and although the bottom is covered with shells, there are no oysters, have been none, and will probably not be any until some artificial means are taken to restock the place. On these extinct beds there are quantities of old oyster shells, but the spat will not settle. The reason for this is that all of these old shells are covered with a growth of some kind. The special kind of growth varies in localities, sometimes animal, sometimes plant, and again it may be a combination of both plant and animal. In the lower end of the Grand Caillon when examined in the spring of 1909, the growth consisted almost exclusively of small sea anemone (*Aiptasia pallida*); while in Bayou Rosé only a short distance away, the growth was mostly tunicates. Other growths that prevent the settlement of spat are sponges, hydroids and algae. Some of these forms are enemies of the oyster, in that the oyster larvae forms a part of their food. Thus it is that so long as all the available space for spat to settle is already occupied with mucus and other forms of growth, there is little or no chance for the young larvae to get a start.

This then is the great advantage of clean shells. Shells, of any kind, if used as spat collectors, must be clean. Slimy, mucus shells are but little more apt to collect spat than the leaves on a tree. One great consideration then is to have the material used for spat collection, clean from any foreign growth. If oyster shells are used, be sure that they have been exposed to the sun for a considerable length of time. If either the *Gnathaden* or *Area* clam shells are available, and these are bet-



IV.—AN OYSTER BEDDING GROUND.

This is a bedding ground owned by John Paulokovitch, in Barataria Bay. It shows in the area to protect it from the ravages of the storm. The bottom was fenced in with heavy four-inch mesh wire netting.

ter for spat collectors in that they do not permit of so much overcrowding as do the oyster shells, use only those that lie above the water level, as those below water are generally covered with plant or animal growth of some kind.

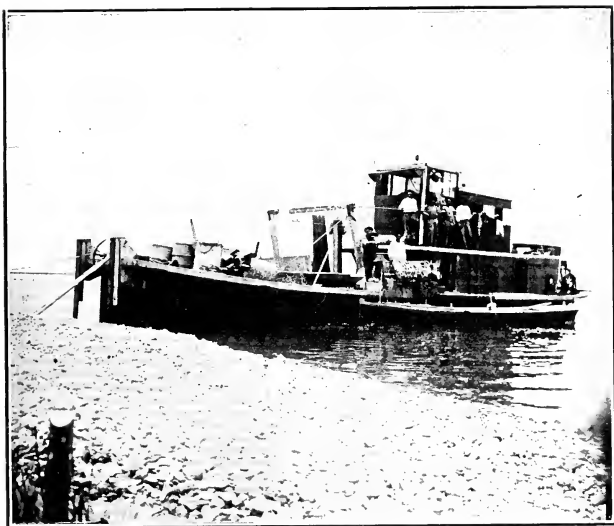
I quote again from Dr. Kellogg: "In this connection, mention should be made of the striking advantage that the Louisiana oysterman may have in material for catching oyster spat. Oyster shells are good for this purpose, but they are so large that each may bear a cluster in a year's time. Smaller bodies would be better. Now all along the coast are great banks of small shells that would make ideal collectors. Many of these, taken from the eastern end of Lake Borgne, bore single oysters. All of which were of good shape. It was seldom that more than one was found attached to a single shell. Several may at first attach, but few can survive. In a second season, clusters might form on these oysters but it would not be necessary to take them up for culling until the end of the second year. It is possible that by using these small shells as collectors the labor culture in Louisiana may for a long time be very greatly reduced."

SPAWNING SEASON.—Let us now consider at what time of the year the shell ought to be placed in the water, to get the best results. Obviously most spat will settle when the water contains the most. In other words, at the height of the spawning season more oyster larvae are in the water than at any other time. Therefore, it is important to know the limit of the spawning season. Apparently in our southern waters an oyster may spawn more than once a season, and in exceptional cases, spawn may be thrown at any time during the colder months. Our records go to show that in the tow, oyster larvae have been gotten in every month in the year, and in almost every week. This exceptional spawning is by no means abundant; as during the winter months, only one or two larvae may be observed in the towing of two weeks or more. Yet the fact that larvae are found, leads us to believe that occasionally the oyster may spawn at any time of the year, in our southern waters. Larvae, from actual observation begin to increase about the last week in March, yet this date varies with the locality and condition of

temperature. The numbers of young oysters increase gradually and reach their maximum from the second week in May to the last week in June. After this, the numbers very gradually decrease until, by the first of September, hardly any are to be found.

Towings, which have been the writer's chief means of determining the spawning season are made with a net seven inches in diameter composed of silk bolting cloth containing 150 meshes to the inch. This net is towed behind a boat. Where records of tows were wanted to obtain a series, towings were made as uniform as possible, that is, they were made from a small power boat propelled by oars at a uniform rate and extending over a period of thirty minutes; during this time the contents of the net were emptied four times. Checks were run at times, to see how nearly two towings would correspond. A second towing being made immediately after the first, in the same locality. The following are some of the results of the number of larvae obtained at different times together with the checks: 1st., 90,000; 2nd., 130,000; 3d., 125,000; 4th, 82,000; 5th., 8,000; 6th, 2,500; the checks were: 1st., 92,000; 2nd., 124,000; 3d., 124,000; 4th., 82,000; 5th., 9,200; 6th., 2,300. There is, of course, considerable difference in some cases, yet it must be remembered that these results are estimated counts, the total being determined from the actual count of a certain proportion. Thus it is, that differences will arise, even if a second estimate be made from a second count of a single towing. On the whole, the numbers indicate that there cannot be very much difference in the total number of larvae in the water, and that the towings represent tolerably uniform conditions.

Since then, the larvae are found in greatest abundance during May and June. It naturally follows that the greatest number of spat will settle during those months. Consequently clean shells planted during those months will be most likely to gather spat. Actually, however, there are enough young in the water during April to be sure of a favorable set. Moreover, shells planted in April are not apt to become fouled so soon as those planted later in the season; since the fouling growth reproduces and increases more abundantly when the water is warmer. Al-



V.—A TYPICAL OYSTER DREDGE BOAT.

These boats are flat-bottomed, and, with the stern-wheel drive, can make their way over very shallow water. Notice the bumpers on the bow for pushing the "flat." Under ordinary conditions, it takes a crew of nine men to handle a boat of this size, and the running expenses amount to about twenty barrels a day.

though our observations are not very extensive along these lines, it has been observed from those who have actually planted shells that the best results can be gotten by laying out the beds in April or early in May. Remember, that at the critical times in the life of the young oysters, that is, when it settles down after being a free swimming animal, the oyster must attach itself to something, if there is nothing but mud, it is smothered, and if bottom is covered with foul growth consisting of the enemies of the oyster larvae, it is eaten up. The point is, to have the material used for collecting spat free from foreign growth, and to have them stay clean as long as possible to give the young oyster a fair chance of holding his own in this life.

WORKING OF THE BEDS.—Supposing then, that we have scattered clean shells and the spat has settled, we must not think that the work is over. The same as on land, the more a man “works” his farm the better are the results he is bound to get, so in the case of oyster farming, the best results can only be gotten by actually “cultivating” the beds. This consists of breaking up the clusters. As stated above, several hundred young oysters may become attached to a single shell. Normally, there is chance for but few of these surviving, the rest must necessarily be smothered out. What do survive, crowd each other and grow long and narrow and are generally poor, because they are under such a strain to exist. Nature can be aided here and the result will be large, round, plump oysters. In our waters, oysters will be ready to “break up” at the end of eight months; ten to twelve, however, is about the right age. At this time all of the oysters ought to be taken up and the clusters that have formed, broken up. If the bottom is comparatively soft, it is better to let the oysters attain a larger size than if they are planted on a hard bottom, the reason being that the soft mud is more apt to smother a small oyster, especially if they are thickly planted and come to lie one on top of the other. In the deeper waters, these clusters can be broken up quite satisfactorily by means of the dredge. The dredge is dragged over and back on the beds. It kills but few oysters and breaks up the clusters. It will, however, be found more satisfactory to cull the oysters by hand and separate each individual,

thus giving each oyster the greatest possible chance to develop into a genuine "Louisiana oyster." By thus breaking up the clusters each oyster is given a better chance to survive and the shell will widen and deepen; whereas, if left in clusters, the oysters crowd each other and the shell lengthens and flattens and forms the characteristic "Coon Oyster."

It has been objected that dredging ruins oyster beds. There are no just grounds for this except jealousy. On the contrary, it benefits the reef, by breaking up the clusters of long narrow oysters that are found in all reefs. It cannot, however, be handled with as good results in waters less than 8 or 10 feet deep, and should therefore be restricted to such areas. It can, however, be used profitably for "cultivation" on one's own bed.

Under favorable circumstances, with proper cultivation, oysters raised in the warm waters of Louisiana can be put on the market in excellent condition and medium size at the end of 28 or 30 months, but this demands a certain amount of labor expended on the beds. We have spoken of the "breaking up" of the clusters at the end of about 8 or 10 months, but the labor does not end here. We have taken it for granted heretofore, that the oyster beds were located in brackish waters. (For selecting of bottom see later.) In order to obtain the best market prices, the oysters must have the best flavor. This can only be gotten by transplanting the oysters to a new bottom. As will be explained hereafter oysters grow more rapidly in brackish water than in salt or water with high density. But the flavor of these has a change to the flat taste to it and the meat is lacking in firmness. To obtain these two desirable qualities, the oyster must be transplanted to water that is "salty," that is, of a higher density, say 1.018 to 1.024 specific gravity. One month of salty water is sufficient to obtain an oyster with good flavor and texture.

TRANSPLANTING.—The best time for transplanting to the so-called bedding grounds will be found to be during the second fall after the setting of the spat. At this time, the weather is generally cool enough to allow handling the oyster for some considerable time out of the water. It also gives the oyster a chance to live its second summer in brackish water and so at-



VI.—ON BOARD AN OYSTER DREDGE BOAT.

This shows the cross beam and center post which are used in handling the dredge..



tain a larger size. At the time of transplanting it may be found necessary to cull the oysters, as there will be a large number of young of the spawning season preceding that fall, attached to the shells of the oysters. It is best to cull these off unless the oysters are to be marketed within a month after the transplanting to the bedding ground, even if they are not put back on the raising ground to be transplanted the fall following, as they necessarily retard the growth of the older oysters. If the oysters are culled and separated at this time, it will be found that when they are tonged up for the market they will require little or no culling and can be taken up just as they are needed.

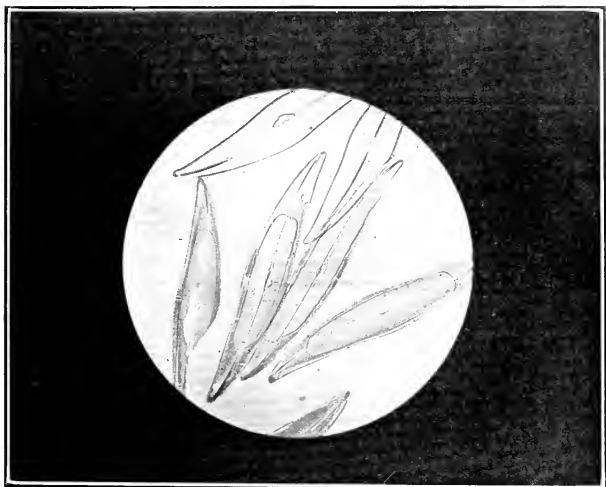
The transference of oysters to a new bottom, especially as in this case, where there is a considerable difference in the saltiness or density of the water, invariably causes a cessation of growth, till the oyster becomes acclimated to its new conditions, when it will again resume its growth; but the increase will not be so rapid as when left in brackish water. One month is sufficient to obtain an oyster of desirable qualities after it has been transplanted to water of high density, but ordinarily the oysters are left from 3 to even 4 months. The high class market at the present time, practically demands that oysters be handled thus, as it produces an eating oyster superior to any that are produced on the Atlantic Coast. The oyster is plump, not bloated, of firm texture yet tender, of admirable flavor, and of desirable size. An oyster marketed from brackish water lacks the flavor, and is often bloated; while one raised in salt water is small, and lacks the tender qualities of the transplanted oyster.

SELECTION OF GROUNDS.—We now come to a consideration of the selection of bottom. We have seen that as far as the setting of spat is concerned, any bottom where the water is the least bit brackish, may be utilized; but there are other considerations which will not permit of the young larva growing beyond a certain stage, and then again if it lives, the growth may be so slow as to be absolutely impracticable for commercial purposes. These conditions are: 1st *currents*, which carry the food supply, fresh water for respiration and remove waste; 2nd. *amount* of food supply obtainable in the water; 3d. *density* or saltiness of the water, and 4th. *condition* of the *bottom*. Let us consider these in the order named.

CURRENTS.—Probably the first factor determining successful oyster culture is the condition of the currents, their force, direction and source. These serve three purposes in the welfare of the oyster. 1st, they constantly bring fresh supplies of food; 2nd, they provide fresh water for respiration; and 3rd, they carry off waste matter. As has been stated above, the oyster lives principally on diatoms or microscopic plants. These are found almost universally in the water, both fresh and salt. The oyster strains the water through its gills and takes out the diatoms together with the sediment that may be in it. Supposing that there are many oysters lying close together and that there is no current, one can readily see that the water immediately over the bed may soon become deprived of its supply of diatoms; while a slight current will carry off the strained water and bring fresh in its stead. Dr. Graves of Maryland has estimated that the average oyster will strain through its gills about 1-4 of a quart of water per hour and that it requires approximately 40,000 diatoms to feed one oyster per day. The supply is, according to that statement, abundant on our coast as the estimated count of diatoms in various waters runs from 19,000 to 110,000 per liter (about a quart). The former count being made from water taken from a current, and the latter from the bottom water in a shallow lagoon or bay averaging 2 1-2 to 3 feet in depth.

Although the diatoms may be abundant in water at large, they soon become exhausted from water immediately surrounding the individual oyster, especially if it lies in a crowded reef, providing, of course, there are no currents to replace the waste water by fresh, bearing more food. This is often the case in small lakes, lagoons, and coves. In such sheltered places, oysters are frequently found, but if they are of any size, they are old, the shells usually thickly bored and do not present the healthy appearance of the young oyster.

Secondly, the currents supply the oyster with fresh, oxygenated water, or water in which air is dissolved. The oyster must breathe oxygen the same as a person. The gills of the oyster are the thin, striated flaps on both sides of the body, and, like those of the fish, serve the same purpose, namely, that of taking up the oxygen that is in the water and giving off carbon dioxide.



VII.—DIATOMS (PLEURASIGMA) (X 130 dia.).

This represents a typical form of oyster food. At times this form of diatom is so abundant that it constitutes 85 per cent of the plankton towings, and often as much as 96 per cent of the stomach contents of the oyster. This, however, represents only one type of oyster food.

The oyster does not breathe in, the water, in the true sense of the word, but it can be said to breathe the oxygen that is mixed or dissolved in the water. Here again, if there are no currents, the water immediately surrounding the oyster becomes exhausted of its supply of oxygen, and the growth of the oyster correspondingly retarded. The surface of the water in contact with air dissolves a certain portion of it—in fact, it may be saturated with air. This air is then distributed to all parts of the water mainly, though not entirely, through currents. Cold water will dissolve as much more air in proportion, than warm water; as hot water will sugar, more than cold. Consequently, the water on oyster beds that lie in sheltered shallow bays, where there are no currents, and where the sun warms the water to such an extent that it may actually feel hot to the touch, contains little oxygen which oysters may use. So here the currents by bringing supplies of water containing air, aid the growth of the oyster.

Thirdly, and lastly, the currents carry off the waste matter. All excretions, sediment that is collected and thrown off, and everything of that nature, which, even though it may not be actually detrimental to the life of the oyster, naturally retards its growth, is carried away, and the oyster kept clean and healthy.

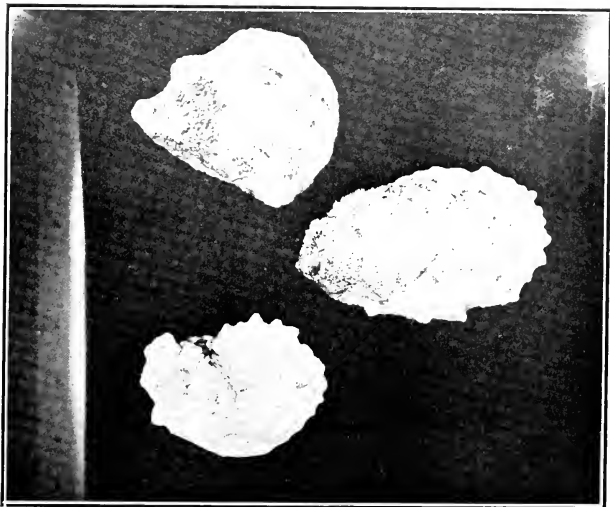
The currents then play a very important role in the life of the oyster. Upon that principally depends the rapid growth of the young. An oyster in a sheltered cove may take several years to attain the same size as one that is situated where there is a constant current of water in one direction or another. Therefore it is an all important consideration in locating a bed to determine the currents, not only the fact that there *are* currents, but as we shall see later *from whence* those currents come. On our coast there is no current too swift for an oyster, in fact it may be said that other conditions being equal, the faster the current, the greater the growth.

The tides on the coast east of the Mississippi river are slight, averaging but 11-2 feet, with only this rise and fall on the coast line, it is not surprising that in many of the inland bays and bayous there is no noticeable tide. The tides are, however, influenced to a large extent by the direction of the wind, and it can be said that the water will rise or fall according as the wind

is from one direction or another. These wind tides, although they may be considerable are, nevertheless, very irregular, and they cannot be depended upon to produce the necessary currents over an oyster bed. It is important then to select grounds where the water is affected by the daily tide. However slight that may be, it can always be depended upon to produce a more or less *constant* current. A bedding ground located in a cove although it may be subject to the influence of the tides, receives but little current, the water merely rising and falling. At the mouth of such a cove there is a current due to the water flowing in and out as the tide rises or falls; and this current is great or less, according as the bay is large or small.

FOOD SUPPLY.—The average oysterman can no more determine the amount of available oyster food in the water than the average man can determine the available heat that will be produced by each pound of coal that he burns. As stated above, diatoms are more or less abundant in the water everywhere, yet it is well to know, that the places in which they multiply most rapidly, are warm, brackish waters. It is in such places that they are found in such abundance as to number as many as 110,000 to the liter, or about a quart. These microscopic plants multiply very rapidly when the conditions are right and these are most favorable in our shallow, brackish waters, where the bright sunlight warms the water and enables them to manufacture their own food from carbon dioxide and water. Such shallow brackish bays may be termed the breeding places of the diatoms, not that they don't multiply anywhere else, but because it is here that they increase with the greatest prolificness. Here, then, is oyster food in great abundance, but in places that are not at all suitable for oyster growth. How then can we get the oyster and food together? Simply this, the currents, At low tide, the water will naturally flow out of the bays and with this drainage immense quantities of the diatoms are carried out and float down with the currents. Here, then, is another favorable condition for an oyster bed, namely, in such localities that the currents that pass over it at the ebb tide shall come from such bodies of water as are shallow and brackish.

Such an ideal condition for oyster beds is found in Grand Bayou du Large, Grand Caillou, Bayou Rose, Terrebonne Parish,



VIII.—OYSTER SHELLS.

These are the shells of oysters raised on bottoms comparatively free from the boring sponge. Contrast these with the shells shown in Plate IX. The quality of the oyster would be the same, but note that the shells apparently have had a more rapid growth.

where there are continuous currents in one direction or the other. The ebbing tide brings currents from the shallow brackish waters of Caillou Lake, or as it is commonly called, Sister Lake. Another such situation is on the so-called "Government" reef at the outlet of Bayou St. Denis, Barataria Bay, where the ebbing currents come from Bayou St. Denis which in turn receives its supply from many shallow bays that open into it. And so on, we might name hundreds of areas which are most favorably situated for oyster culture.

It might be stated in passing that when oysters are transplanted before marketing, the condition of currents need not form such an important factor on the transplanting or bedding ground. It is, of course, well to have them, but in this case actual growth is not sought, and the oysters are left on the bedding ground but a comparatively short time. There are, however, bottoms that are admirable for both oyster growing and bedding, and so why bother with inferior locations?

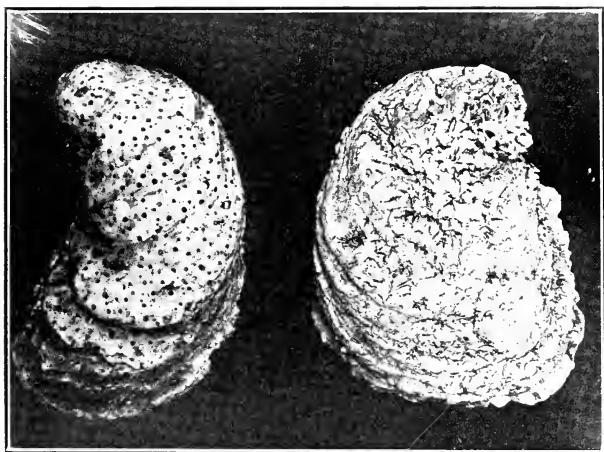
DENSITY.—Let us remember that conditions governing oyster culture in Louisiana are different from those anywhere on the Atlantic Coast. The soil is fine and generally in the form of mud, more or less soft; the waters are shallow, containing a considerable amount of sediment; and the temperature is high in the summer months. These last two facts combined, produce conditions which prevent utilizing otherwise favorable bottoms. The density recommended for best results on the Atlantic coast is from 1.0190 to 1.0230, specific gravity. The density best suited to the growth of the young oyster in Louisiana is from 1.0080 to 1.0150. In waters of higher density, the spat will, of course, settle; and if it is early in the season, may attain considerable size, but under the hot sun of our southern states and in the shallow waters, the temperature rises to such an extent in the denser waters, that the oyster is either killed or retarded in growth. Where there is a current over the beds from deeper waters, the temperature will not rise so much and consequently the oyster will thrive better than if the water had no other current except the rise and fall of tides. It is not advisable, however, to risk starting a bed in water of high density or saltness. 1.019 is too salt, and although the young may grow as long as the weather is cool, they cannot survive the heat which the high

density water acquires in mid-summer. After the oyster has reached the age of one year, it can withstand the temperature, and at that age may be transplanted to salt water without danger of its dying.

FRESHETS.—Although an adult oyster will withstand absolutely fresh water for as much as ten days, the young will perish much sooner; and although fresh water at the surface does not always indicate that it is so at the bottom, yet it is not practicable to select oyster lands that receive currents straight from some fresh water lake or bayou, and which are subject to freshets, for in time of heavy rains, the oysters, even if they are not killed are checked in their growth. Thus another point to consider in securing oyster bottoms is to have the water at a fairly constant density, not too high, and not subject to the influences of freshets.

CONDITIONS OF BOTTOMS.—One great difficulty with which the oysterman of Louisiana has to contend is the muddy bottom. Except where there are strong currents, more or less mud is found on all bottoms. If this is soft, the oysters sink down and smother. If it is soft on the top, and at a depth of a few inches hardens, the oyster may not die, but have a hard time to live. Often the bottom is hard enough to support the oysters, but at the next storm, or after a series of high tides, a deposit may settle on the beds, which will either smother the oyster or check its growth. The quantity of sediment that will settle in a short time may be great enough to cover an entire bed to such an extent as to kill every oyster on it.

In the spring of 1908 west of the jetties of the Calcasieu Pass, the bottom was hard and well packed, so that a man could walk over it and hardly leave his foot prints. A heavy storm struck that place from the eastward, and in less than a day and a half the part protected by the jetty had been covered by a deposit fully 12 inches in depth. There are many other places in the state where this is liable to happen, thus destroying all possibilities of oysters or any other stationary form of life growing on that spot. Where there are constant currents, the sediment in the water is prevented from settling, and consequently the bottom is hard. Here the oyster will thrive, if it has been transplanted, and the young will settle and grow, if the cultch is provided for



IX.—THE WORK OF THE CLIONE.

These are two typical shells taken from the waters of Baratania Bay, showing the heavy boring that is done by the Boring Sponge. Although the shell is perforated with small canals, there is no direct damage done to the oyster. Only occasionally does the Sponge bore through the shell and kill the oyster.

them. Such bottom need no comment as they are ready for any oysterman. A few years ago there was a rush to get leases on the old depleted reefs. The reasons were obvious. 1st, it is the general opinion that where oysters have been grown in the past they are apt to thrive in the future; and, 2nd, here were grounds that might naturally be soft, yet the old reef has formed a layer of oyster shells. Such bottoms have been mostly, if not entirely, leased at the present time.

There are many acres of bottom where the conditions are quite favorable to oyster culture, but which are more or less soft. Such bottoms, if not too soft, can readily be built up by throwing on a few loads of shells for a foundation. Oyster shells are preferable for this, since they will not sink so readily as the smaller so-called clam shells. After a bed is formed, small shells may be thrown there for cultch in the spring of the year. Thus an oyster bed may be started, where before the bottom was too soft; and whatever cultch was planted would sink below the mud.

Besides these, there are large tracts of land where the bottom is so soft that it is impracticable to start an oyster bed under any circumstances. Such a bottom is illustrated in the case of the experimental bed started at the Gulf Biological Station, which was approximately one hundred feet square, where one thousand bushels of clam shells were planted and on top of these seventy-five bushels of living oysters. These were planted in the summer, and the following spring, absolutely no sign of the bed could be found, even by running a long pole into the mud. Such bottoms are best left alone, especially since there are such large areas of bottom that can be utilized with little or no work in preparation.

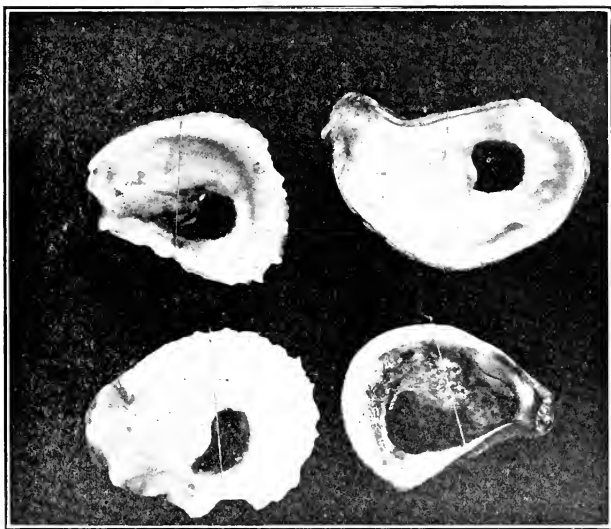
The number of shells that ought to be planted per acre varies according to the condition of the bottom. On hard bottoms where there is no chance for sinking, 50 or 60 bushels per acre are sufficient. If more are planted, it not only results in unnecessary labor, but also in overstocking the area. By overstocking we mean crowding the oysters in a bed to such an extent that there is insufficient food in the water to permit each oyster to grow to its maximum size.



As the bottom becomes softer, more and more shells will be found to be necessary. In some places as many as 5,000 bushels have been planted and did not prove to be enough. Each one must be governed by the location of his bed as to the number of shells to plant. Remember that each shell lying well above the bottom will act as cultch for a number of young oysters, which if separated at the right time, will grow to well formed oysters.

ENEMIES.—We have enumerated above several conditions governing the selection of an oyster bed. The enemies of the oysters may constitute a condition, but we shall not treat it as such, since they are to be found wherever the conditions of living are suitable to each. The enemies of the oyster larvae have been previously mentioned. There are others that prey upon the oysters after they have become attached. Among those that are found on the Louisiana coast are: the parastic worm, *Bucephalus*; the stone crab, the oyster drill, *Purpura*; the clam drill, *Lunatia*; the string-rays; skates and the drum fish. There are other forms that indirectly may be considered enemies, they do not directly prey upon the oyster, but in one way or another retard its growth. Of such, are the hydroids, commonly known as Frog's hair, algae, or sea moss, mussels, tunicates, sea anemones, and the boring sponge, *Clione*. All of these but the last are found attached to the shell, and by taking up the food and absorbing the oxygen, starve and smother the oyster. Sometimes their numbers are sufficient to kill the oyster or to render it unfit for the market. But this rarely occurs where oysters are handled or cultivated.

The boring sponge is the cause of the outside layer being perforated by numerous holes and canals. This in itself rarely causes any harm to the oyster unless it makes its way to the inside, which it seldom does. The parasite worm, *Bucephalus*, although frequently found does but slight, if any, damage to an oyster bed. The larger sting-rays and skates are accused by oystermen of doing considerable damage. But it is doubtful that much destruction can be attributed to them, since authentic reports are lacking; and what may be laid against the ray might more likely be the result of drum fish depredation.



X.—OYSTER SHELLS (Two-fifths Natural Size).

Contrast these with the shells shown in Plate XI. These shells are from oysters grown in brackish water, where there was but little sediment, and then transferred to salt water, where there was practically no sediment. Note that on two of them there are traces of sediment streaks which the new layers of shell deposited in the clear water have not covered entirely.

These rays moreover are only found in places east of the Mississippi river and around the delta region.

The stone crab, so called from its extremely hard shell and powerful claw, is guilty of helping himself to oysters. These crabs break off bits of the outer thin shells with their claws and then with the small pinchers located on small, narrow feet, pick out the oyster piece-meal and eat it. The younger oysters most often fall prey to these forms, and in fact it is not likely that a three-year-old will be attacked unless it has fresh growth on the rim of the shell. No doubt these crabs would prove a menace, if they but occurred in sufficient numbers. However, they are found in scattering numbers and are not abundant enough in any one locality to prove detrimental.

It is not so difficult as it is nervy to capture these crabs in their burrows. They are delicious eating. The flesh is as fine as that of any other of our shell fish. It might be suggested, therefore, that where the oysterman are troubled with these, they might make a raid and thus doubly benefit themselves by saving the oysters and obtaining food.

The Oyster Drill, *Purpura*, and the clam drill, *Lunatia*, commonly called Perrywinkle, or Pennywinkle, conch and borer, are very annoying in some localities. Their ravages are, however, restricted to bedding grounds in the salter waters, and very seldom are they found in the brackish waters, where the best raising bottoms are located. The clam drill, is further restricted, in that it can only bore through a very thin shell, and consequently, it can only attack oysters under four months of age. The boring can at once be detected as being done by one or the other, in that the oyster drill produces a clean-cut straight hole, while the other makes a decided bevel on the outside. It is the popular opinion that the drill always bores through the shell where the eye or muscle is attached, thus destroying the muscle and killing the oyster. On the contrary, the *Purpura* may drill through the shell at any point, and it kills the oyster by pouring around it its own digestive fluids onto it.

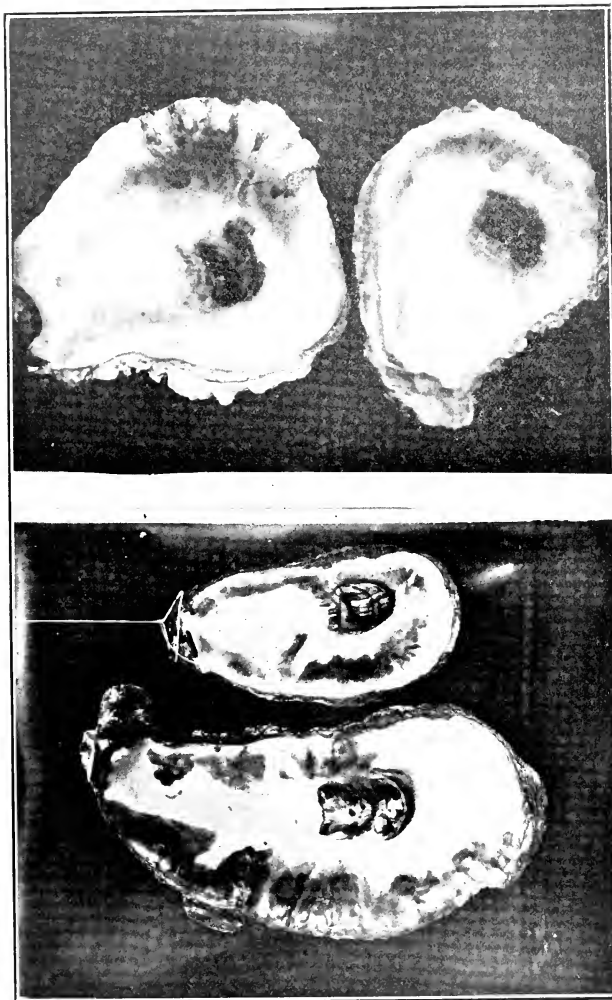
It is the popular opinion among many oystermen that the *Purpura* or oyster drill, bores the hole through the shell by using the apex of its shell as an auger. This is absurd, the mere shape of the hole ought to remove any idea of this. The shell is actually

filed through. The *Purpura* is provided with a long narrow proboscis over the end of which works back and forth a ribbon lined on the outside with sharp recurved rasps. The ribbon or radula, as it is called, is formed just as fast as the teeth are worn down. The result is that when examined under the microscope the end rasps are found to be nearly flat; and they gradually appear sharper as they near the base. By a steady long-continued to and fro movement of the ribbon over the end of the proboscis, the shell of the oyster is gradually bored or filed through.

After the oyster has been partially digested and killed, it opens its shell the least bit, and the currents carry down with them the scent of the dying oyster. This is readily detected by other drills, and they start up against the current to find and share in the bountiful feast prepared by one of their fellows. The conch will notice the scent as much as eight or ten feet down stream and will work its way up, travelling always towards the source of the scent, i. e. directly against the current, whereas one six inches away from the oyster on the upside, will show no sign as having noticed the odor; showing that these animals detect their food by smell, and that this scent is very acute. Thus it is that a single oyster is often covered with several *Purpura* and there are others waiting around, working to get their "foot" into it.

The drill like its cousin, the *Lunatia*, is seldom if ever found in localities where oyster *raising* is the most profitable. They are not found in the brackish water of our inland lakes. In fact, they are seldom seen in water under 1.0150 density. They are, however, a source of annoyance on all of the transplanting grounds. There is no practical method of getting rid of these. Their numbers may, however, be diminished by working over the beds and separating the drill into a receptacle and throwing them on dry land in summer and removing them to fresh water in winter. In summer, the heat of the sun is sufficient to kill them, before they can find their way back to the water, even if only a few feet distant.

THE DRUM-FISH.—This dreaded pest of our waters is found in the salt water everywhere on the coast, and often wanders up into the brackish streams, either unintentionally, or in search of



XI.—OYSTER SHELLS.

These represent the type of shell produced by an oyster raised on a soft, muddy bottom, where the sediment is continually being stirred up. Note the streaks of sediment along the edge of the shell, that have been discarded by the oyster. This condition cannot help but retard the growth of the oyster. These streaks of sediment would be washed away were the current strong enough. But where they are not carried off, they, being irritating to the mantle of the oyster, are continually being covered over with new layers of shell, till the condition is reached, as shown in the upper right-hand figure, where the streaks are almost obliterated, and the water, having remained clear for some time, no new streaks have been produced.

food. The traces of its ravages are evident. The tips of the oyster shells are broken off, as if they had been chiseled with a cold chisel. These fish are especially partial toward oysters that have been freshly bedded. The damage to natural reefs is slight and likewise to oysters that have lain on the bottom for some time. It is never safe, however, to take any chances; as these fish are voracious eaters and a school of them may destroy an enormous number of oysters in a bed. Their ravages are confined to the bedding ground. Occasionally traces of their destruction are seen in brackish, raising bottoms, but not enough to warrant taking any special means to keep them out. Where oysters are transplanted to salt waters in preparing them for market, special precautions must be taken to protect them.

In some places stakes are driven down close enough to exclude Drum-fish, yet not enough to prevent the current from flowing over the beds. A better plan of protection, and one that is not so expensive, is to fence in the bedding ground with wire netting. Galvanized netting of four-inch mesh made of number twelve wire is the most satisfactory. This will not easily rot away and is strong enough to hold against the attack of large fish. The writer has seen a large Tarpoon or White fish get accidentally caught in a bedding ground surrounded by an ordinary two-inch mesh chicken wire, and in its efforts to get out, tear the netting as if it were twine.

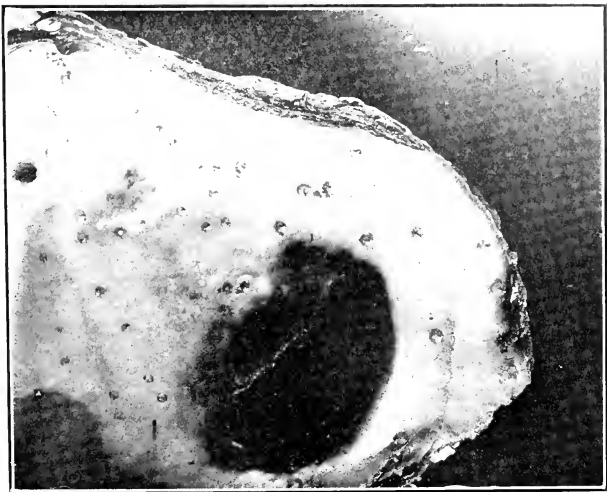
In fencing in, it is well to have the stakes creosoted to keep them from being worm eaten. Use only good, strong stakes, well driven down. These may be placed anywhere from ten to twenty feet apart according to the quality of stakes used; twelve feet will be found to be about the right distance. If extra stakes are used the distance may be increased, if not so good, lessened. The corner posts must be braced, for the ground is never solid enough to prevent its giving, which often allows sag enough to permit the entrance of fish. The braces are most conveniently and effectively placed by being run from base of the next-to-corner posts to the top of the corner stake. If the corners are not braced, it is well to round them, so that the strain will not all come on a single stake. The netting is best laid on the inside, so in case that porpoises or large fish get accidentally enclosed, in trying to get out, they will not tear the netting from the

posts. A gateway is easily and effectively made by having one end of a wire attached to a movable stake which can be swung aside or laid across, so as to open or close the entrance.

In several places along the coast, the fishermen utilize whatever drum fish that may be caught by salting and drying them. In this form they are quite palatable, having the taste of salted cod. When properly cured in this manner, they are tender, and can be served up in the form of fish-balls to make a tasty dish. This suggests a remedy for reducing the numbers of the fish. Instead of throwing back the fish when they are caught in the seine or elsewhere to the waters, they could be saved as an edible fish and salted down for the market. By thus creating a demand for the fish, it would be taken from the waters, and instead of increasing in numbers, as it would if they were to be thrown back, its numbers are at least held in check. An example of a created demand for an obnoxious fish is seen in the case of the dog fish found along the Atlantic coast. This fish was formerly a nuisance to the fishermen and they would not handle it in any way, casting out of the seine any that may have been caught. The result was that the dog fish increased to such an extent that something had to be done. This was accomplished by creating a demand for the various parts of the fish, and today, what was at one time a useless fish, is being converted into many articles of use; in fact, nearly every part of this fish is being utilized for some purpose or another. Cannot Louisiana create a market for such obnoxious fish as the drum and the gar and thus help to reduce the numbers of fish detrimental to a valuable industry and to other game fish?

DEPLETED REEFS.

RECOVERING OF DEPLETED REEFS.—Within the last year there has been considerable agitation in regard to leasing depleted reefs. The contention being that there having once been natural reefs, or natural places for oysters to grow, and that although every live oyster may be tonged, yet the reef if left to itself will soon recover and bear oysters in plenty. This is a mistaken idea. A reef, if it is thoroughly depleted, that is, practically every live oyster taken off from it, will probably never recover



XII.—YOUNG OYSTERS (Natural Size).

The bedding ground from which this shell was taken had been planted with fresh oyster shells just ten days before this picture was taken, so that the oldest spat shows not more than a ten days' growth after attachment. This shell had attached to it 79 oyster spat, and in two weeks more it would have been literally covered with the young. Out of this number that became attached, only three or four could possibly survive unless the cluster were broken up.

no matter how long it may be left undisturbed. The reason for this is obvious; the dead shells that are in the reef, and there may be quantities of them, are worm eaten, and covered with all kinds of foreign growth. This, as stated in the first part of the bulletin, absolutely prevents the attachment of any spat. Such animals as the hydroids, sea anemones, tunicates and others, that constitutes this growth, will devour every oyster larva that settles within their reach. Other forms will smother the young immediately or shortly after its attachment. Thus on these old "moss-covered" shells there is no chance for the young oyster to live, much less grow, and build up the reef. In this case then, a reef, no matter how prolific it may have been formerly, is a depleted reef, and will remain absolutely barren, until artificial conditions produce a suitable bottom.

A so-called depleted reef, may, if left untouched, recover in the course of time. In the case mentioned above, the supposition was made that all living oysters had been taken off the reef, preventing possible hope of recovery. Here, we take the supposition that there are still a few live oysters left on the reef. If left undisturbed, these will either be killed or will die, and the two valves of the shells separate. No matter how foul the outside of the shell may be, the inside is always clean so long as the oyster lives. Upon the death of the old oyster, then, there are left exposed the two clean surfaces of the inside of the valves. These form suitable places for the attachment of spat, and they are soon utilized by oyster spawn in the water. Out of the numbers that become attached, several may survive. These in turn may be broken off and separated, and then killed or die, exposing *their* surfaces for attachment. Thus in the course of years, the reef may again build up and become profitable, the time depending on the number of oysters left on the reef. Usually, however, the time taken for such a reef to recover will be six or eight years. The nucleus of recovery being the inner shell of oysters as they die. The idea being, that a reef will recover, not due to the actual presence of the adult oyster, but to the fact that it leaves behind it when it dies a center for young oysters to grow.

Louisiana has at present but few natural reefs which can be considered as such. In many places there are reefs, so-called

natural, but these are so far depleted that there is little chance for recovery so long as they are fished on. If left undisturbed, they would build up again, but the time required for this could be made more profitable to the state, and especially to the industry by cultivating these grounds and supplying the already hardened bottom with a suitable cultch. There are no bottoms, at the present time, profitable to oyster raising, that ought not to be subject to lease. The large reef off Last Island together with possibly several small ones in the Calcasieu Pass and Mississippi Island are the only ones that may be considered as natural reefs.

CULLING OF OYSTERS.—The practice commonly demanded of culling oysters on the reefs and throwing back the shells is good, in that it maintains a suitable bottom. The shells thus returned, soon after taking, are in themselves unsuitable for cultch, since they are covered with plant and animal growth. Practical results and large returns could be gotten by drying these shells and then returning them. This can, however, be done only on private beds. On public reefs the best that can be done is that, that is required, namely, to cull and return the shells to the ground from which they were taken. This keeps the bottom in such a condition that it can at any time be leased and made to return a good profit.

GENERAL CONDITIONS.

NECESSITY FOR CULTIVATION.—Louisiana has reached the stage that Maryland did many years ago, namely, that of the depletion of natural reefs. The oystermen must wake up to the fact that no longer is it profitable to depend upon going from reef to reef and obtain a handsome return for a day's labor. The time has come when the oyster must be cultivated. The leasing of ground gives a man control of that area, and he can thus acquire a right to utilize the bottoms of any particular section for his own profit and to exclude others from molesting what may be called his own personal property, for oysters raised on leased bottoms are such as much as a horse or cow. Having then been granted this privilege, it should be natural for a man to make the most of it.



XIII.—A FAMILY BREAKFAST.

The borer in the center of the group is the guilty one. The others are late comers, having scented the meal and followed it up. There were six individuals after this one oyster, but two dropped off before the photograph could be taken. The one on the right is in the best position to profit by the meal which another has provided, being at the outer edge of the valves and being able to get as much of the oyster as it needs. It is not uncommon to find groups like this in any place where the borer is found. The borer is very keen scented and will follow an odor, up current, for a considerable distance.

A farmer works his land and tries to plant his crops to the best advantage. Oyster bottoms should be worked with the same interest, and they can be made to pay eight or ten times more per acre than a like area on land. Cotton will grow if planted on any land, but to get the best returns conditions must be studied. It will do better on some land than on others; it must be cultivated and the weeds destroyed; it must be sprayed and planted early to protect it from the boll weevil; it must be picked early, the stalks destroyed, and the ground plowed to prevent devastation from the boll weevil. So with the oyster grounds; they must be carefully selected; proper cultch supplied; the clusters of young separated; when ready for the market, they are best transferred to acquire texture and flavor; and in general the same care given to them as in raising any agricultural products.

ROTATION OF BEDS.—The Louisiana Oyster Commission is extremely liberal in its grants and allows a man far more bottom than he can possibly utilize. By actual practice and experience it has been found that one man with tongs can profitably work only about ten acres; while two in combination may cultivate to advantage twenty-five acres. Where the dredge is used, a considerable larger area may be utilized, but it ought to lie in waters over eight feet deep, as a dredge works to better advantage there than in shallow water. A correspondingly larger number of oysters can be handled than with tongs, but the expense likewise is greater.

As has been stated, under normal conditions, Louisiana can market her oysters the second winter after the setting of spat. Time and labor can moreover be saved by keeping marketable oysters, or better yet, by keeping a uniform size in each bed. The bottom ought then to be laid off into three beds, one, two and three. The first spring cultch is placed on bed one. The next spring, these are broken up into individuals and returned to the same bed; shells are also put on bed two. The third spring the clusters are broken up and returned; also those on bed one are culled again and any young from that season's set transferred to bed two; and bed three started. That fall and winter the oysters on bed one are of size and should be marketed. Bed one is then ready for spat the following spring. By thus rotat-

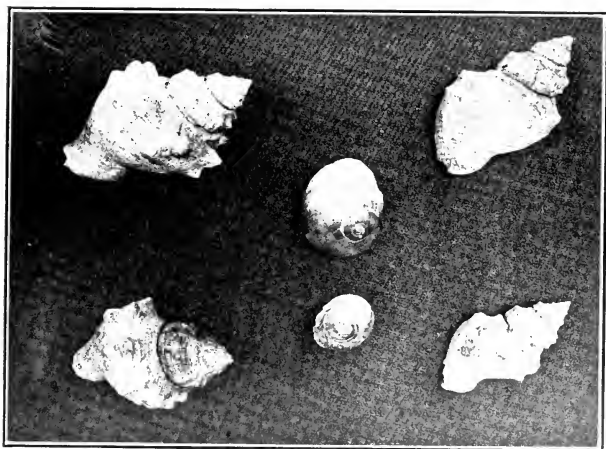
ing the beds, one can derive the greatest amount of profit at the least expenditure of time and labor.

OVERSTOCKING.—If one plants his corn too thick, the ears will become stunted; if too many head of cattle are turned into a pasture, they will be poor and thin; so likewise, if oysters are overcrowded, they will not do so well.. It has been the experience of the writer to examine the stomach contents of oysters from such beds, where the owner complained of not being able to grow his oyster to size in the same length of time that his neighbor did. The average number of diatoms in the stomach of a healthy oyster runs from ten to twenty thousand; the average of ten oysters taken from such a bed in Terrebonne Parish showed but little over three thousand diatoms, the greatest number being eight thousand nine hundred, and the lowest six hundred and fifty. Here it was evident oysters were literally starved, especially since the number of diatoms in the water was normal, namely, eighteen thousand six hundred per liter (or about a quart). Such conditions are apt to occur only in land-locked bays where oysters are numerous and the barren areas not large. Where the currents are constant, however, there is little danger of overstocking, and many beds contiguous with each other will all do equally well.

SUMMARY.—To summarize then: from the egg the oyster develops into a free-swimming individual which may be carried to all waters by the wind, tides, and currents. After two weeks of this life, it settles down and becomes permanently fixed for the rest of its life. Growth to size is attained at the end of two years under normally favorable circumstances.

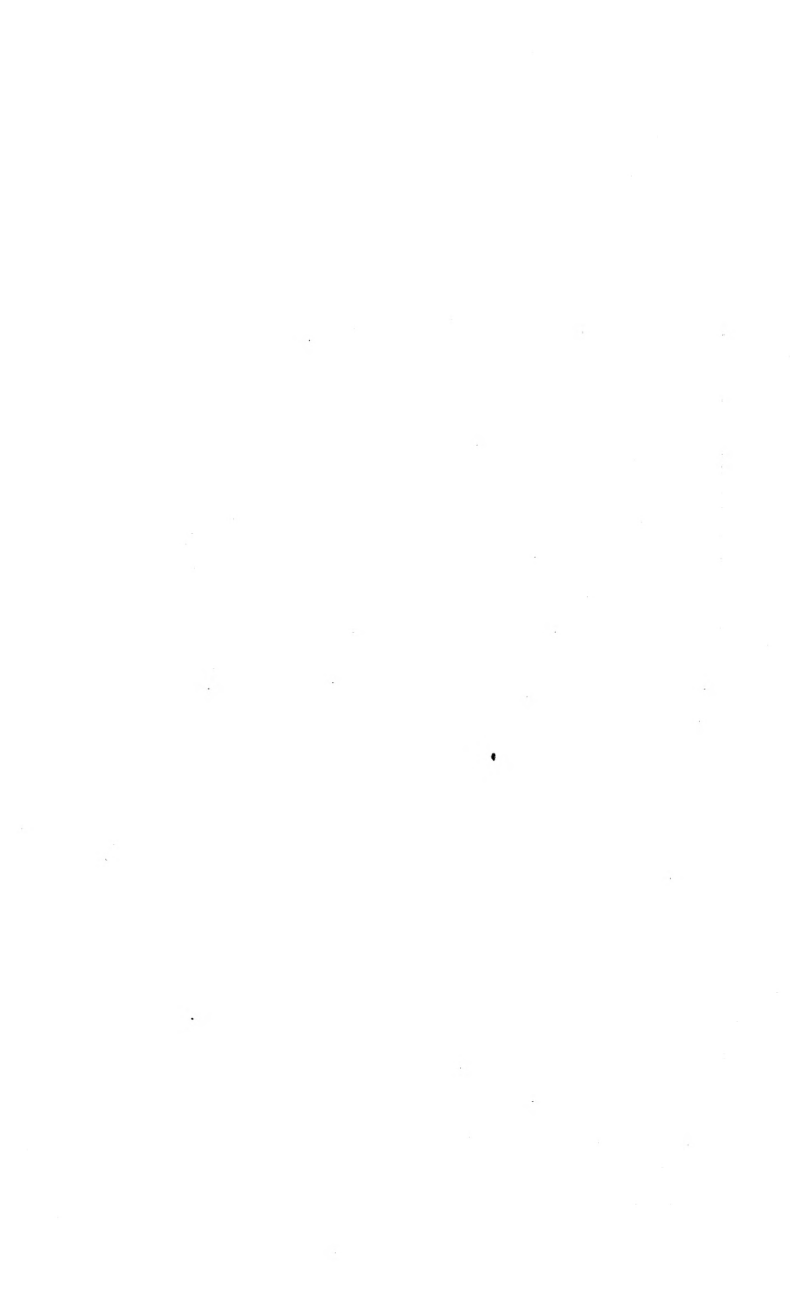
The brackish waters of low density of our inland bays and bayous is more favorable to oyster culture than those of the higher salinities which prove more satisfactory to the Maryland oysterman. This is due to two reasons, 1st, food is more abundant, 2nd, the denser water, having the greater surface tension, becomes overheated during the summer months, which generally proves fatal to the young oysters.

The finest flavor and texture is gotten by transplanting oysters for a month or two, previous to marketing, from the brackish waters to those of higher salinities. This transfer is necessary



XIV.—OYSTER ENEMIES.

The shells in the corner of the plate are those of the oyster borer, or the *Purpura*. These are found in all of the more saline waters where oysters are raised. Their egg capsules are more or less abundant, attached to stationary objects, as piles, and rocks laid out for jetties. Aside from the drum-fish they are the worst enemies of the oyster that are found in the state. The two middle shells are those of the so-called Penny- or Perry-winkle. These will only attack the very young oyster, and even then not to any great extent. The hole that they bore can always be detected from that of the *Purpura*, in that it is decidedly beveled.



where the highest prices are demanded, and should be done the second fall after the setting of spat.

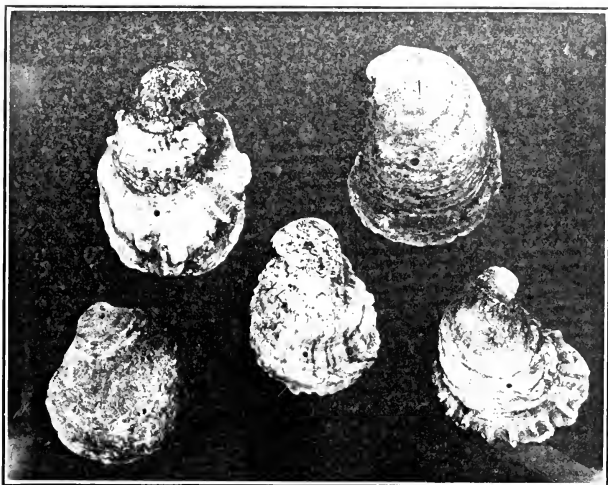
Spat is practically universally distributed, and it only needs a suitable place for attachment to continue growth. Cultch is available in the form of "clam" shells which are found in banks in many places in Louisiana. Also in the form of oyster shells. These must be clean and planted not long before the spawning season to prevent their being covered with foreign growth. The clusters formed on these should be broken up at the end of nine or ten months. This may be done by running the dredge over them, or better yet, by culling them into individuals.

The four conditions governing the selection of oyster bottoms are: Currents, supplying food and water for respiration; amount of food supply obtainable; density or saltiness of the water; and conditions of the bottoms.

The currents supply abundant food, plenty of fresh water for respiration, and remove waste matter and deoxygenated water and prevent, to a large extent, overstocking. These are to be considered in connection with their source, as food material increase more rapidly in shallow, brackish waters. The food supply, then, would naturally be more abundant if the currents flowing over a bed have their source from shallow "mud" lakes. Grounds for cultivating oysters should be selected in brackish waters, not subject to freshets of long duration. In these, the oyster grows the most rapidly and is in no danger of being killed by summer heat. The condition of the bottom must be considered, the harder the better, other things being equal. Too soft a bottom should be avoided, as it is a waste of time and labor, if not a failure, to try and build up a reef on such grounds. Locations that are subject to deposit of sediment should also be avoided.

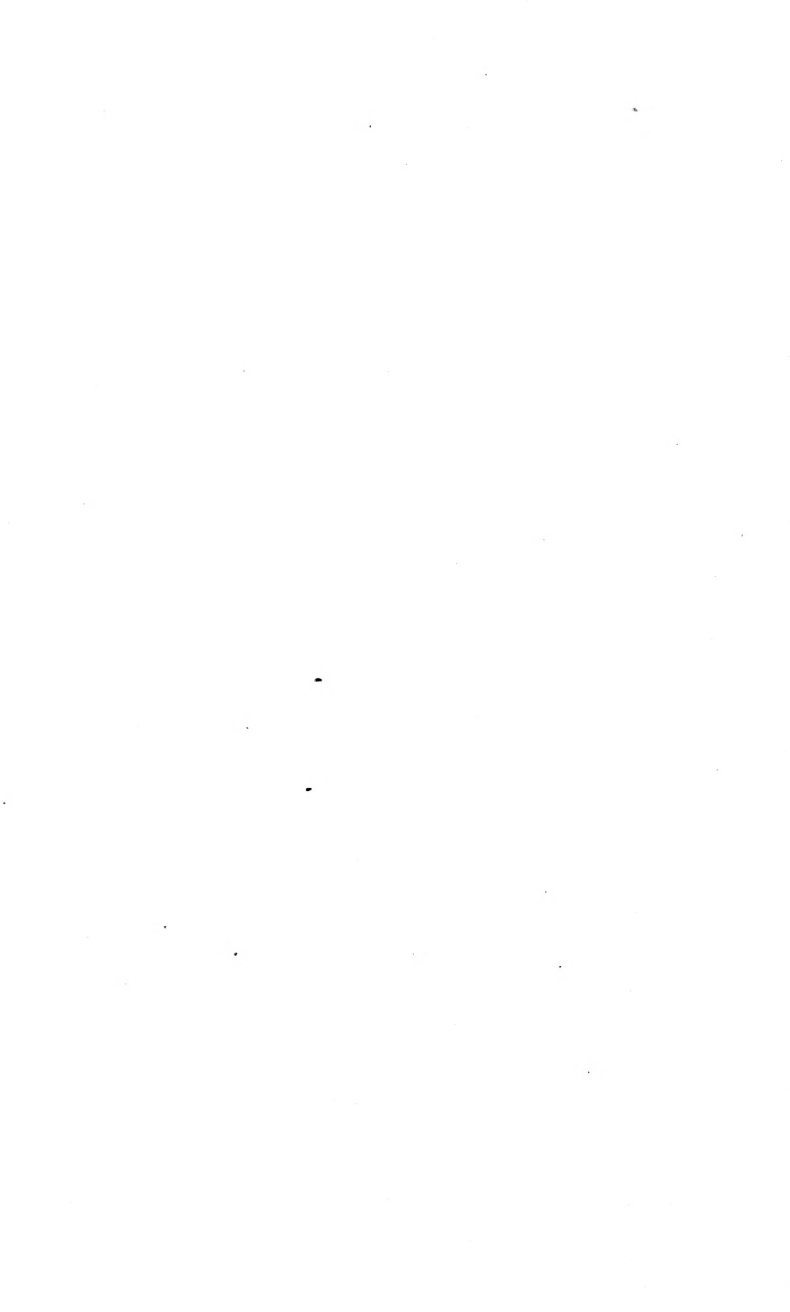
The enemies of the Louisiana oyster are not many, the most detrimental being the drum fish, the oyster borer, and the stone crab. The ravages of the first may be prevented by fencing in the area. The only way to get rid of the drill is, as an oyster-man put it, "*Attrapez le, et arrachez ses dents,*" and in the case of the crab, to catch and eat him.

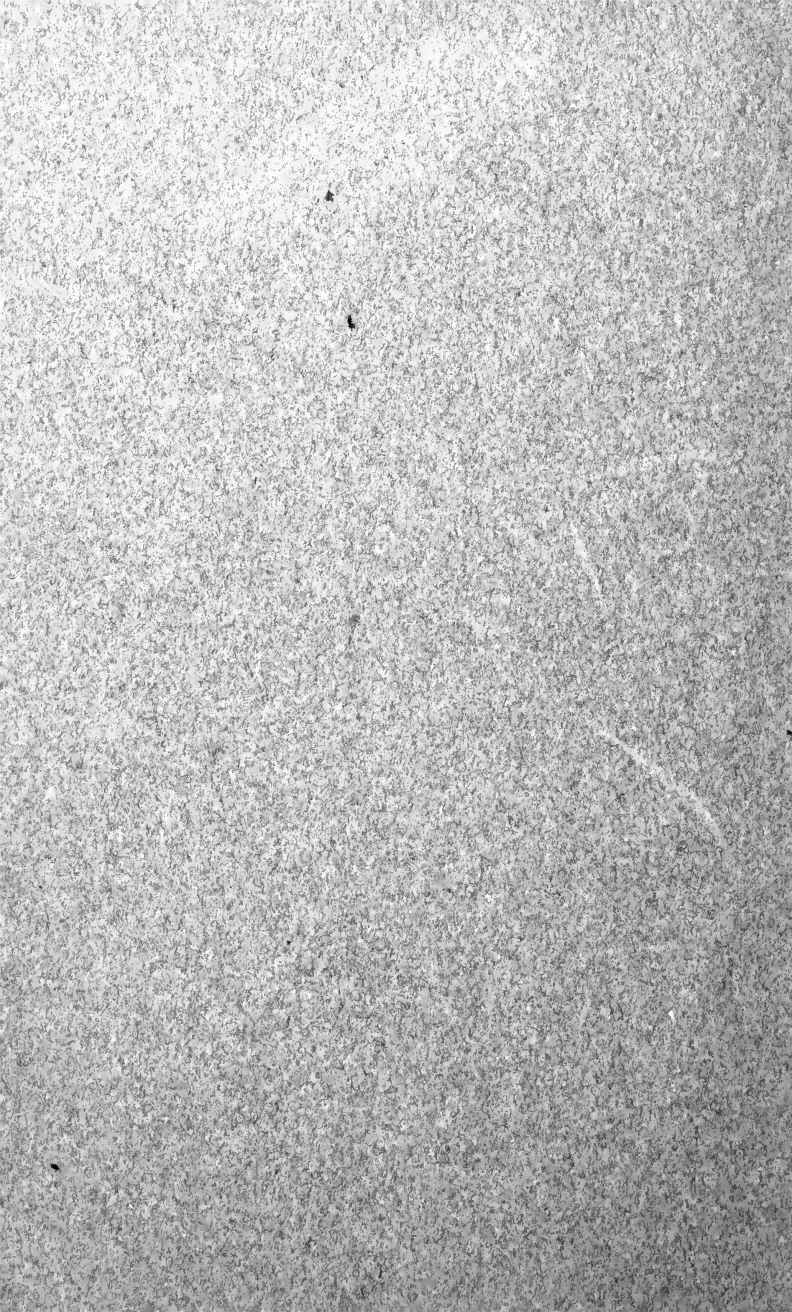
Let us emphasize in conclusion, the fact that our oystermen have got to learn how to cultivate the oyster. The possibilities in this State are limited only by the market. The oyster industry is a great one and is constantly growing greater, and its growth is going to be determined by the amount of care exercised by each individual to produce the finest oysters in the shortest length of time, with the least expense and with the minimum amount of labor. Learn to grow your oysters as you would a field of cotton or cane.



XV.—SHELLS OF OYSTERS KILLED BY PURPURA.

Note the round, clean-edged hole that is bored in the shell. This is done by the rasping "tongue" of the borer, and the work of hours of steady boring. Through this hole the snail pours out digestive fluids which kill the oyster. Only a very small portion of the oyster is eaten, but if there are other borers within "smelling" distance, they will be attracted, and so a single oyster may serve for a meal to several snails.





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